

- Fig. 25. *Xyaste fumosa* (Pasc.).
 26. *Xyaste invida* (Pasc.).
 27. *Gonophora wallacei* (Baly).
 28. *Taphes brevicollis* (C. Waterh.), ♀.
 29. *Ditoneces* sp. near *fusciornis* (Gorh.).
 30. *Caria dilatata* (Fab.).
 31. *Prioptera octopunctata* (Fab.).
 32. *Entelopes glauca* (Guér.).
 33. *Blachia ducalis* (Walk.).
 34. Locustid of new genus near *Gammarotettix*.
 35. *Lema quadripunctata* (Oliv.).
 36. *Apoderus javanicus* (Jekel).
 37. Pterophorid, probably near genus *Corenagua*.
 38. *Bracon* sp.
 39. Homopteron of genus probably near *Brixia*.
 40. *Epania singaporensis* (Thoms.).
 41. *Melipona vidua* (Lepel.).
 42. Capsid sp.
 43. *Holocephala* ? *hirsuta* (v. d. Wulp).
 44. *Megalocolus notator* (Walk.).
 45. Reduviid sp.
 46. *Torophora*, n. sp. near *javana* (Wied.).
 47. *Bracon* sp.
 48. *Mutilla* sp. near *urania* (Smith).
 49. *Tillicera*, n. sp. ? near *T. bibalteata* (Gorh.).
 50. *Cladophorus atrofuscus* (C. Waterh.), ♀.
 51. " " (C. Waterh.), ♀.
 52. *Tenerus sulcipennis* (Gahan).
 53. *Callimerus bellus* (Gorh.).
 54. *Callimerus catenatus* (Gorh.).
 55. *Daphisia pulchella* (Pasc.).
 56. *Spathomeles*, n. sp. near *S. turritus* (Gerst.).
 57. *Zelota spathomelina* (Gahan).
 58. *Erythrurus virilipennis* (Gahan).
 59. *Prionocerus ceruleipennis* (Perty).
 60. *Tetralanguria pyramidata* (Fab.).
 61. *Botryonopa cyanipennis* (Baly).
- Kuching, March 23, 1900.
 Kuching, July 10, 1899.
 Kuching, Aug. 1897.
 Kuching, Jan. 24, 1900.
 Kuching, Sept. 6, 1899.
 Matang, March 13, 1898.
 Sarawak.
 Penrissen, May 1899.
 Kuching, Dec. 13, 1900.
 Kuching, Feb. 2, 1901.
 Kuching, Oct. 12, 1899.
 Kuching, April 4, 1900.
 Kuching, Jan. 16, 1901.
 Kuching, April 24, 1900.
 Kuching, Jan. 17, 1901.
 Penrissen, May 1899.
 Kuching, May 8, 1900.
 Kuching, June 22, 1900.
 Kuching, May 3, 1900.
 Kuching, April 24, 1900.
 Kuching, Sept. 16, 1899.
 Kuching, May 16, 1900.
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 Kuching, July 17, 1899.
 Kuching, Aug. 1899.
 Kuching, March 15, 1900.
 Kuching, April 14, 1900.
 Kuching, March 30, 1900.
 Kuching, Dec. 13, 1899.
 Kuching, Oct. 6, 1899.
 Kuching, June 19, 1900.
 Kuching, Oct. 15, 1897.
 Kuching, Dec. 12, 1899.
 Matang, 3600 ft., June 1900.
 Kuching, May 4, 1900.
 Kuching, Dec. 8, 1899.
 Kuching, Feb. 24, 1899.

2. On the Classification of the Fishes of the Suborder Plectognathi; with Notes and Descriptions of new Species from Specimens in the British Museum Collection. By C. TATE REGAN, B.A.¹

[Received September 26, 1902.]

(Plates XXIV. & XXV.² and Text-figures 56-59.)

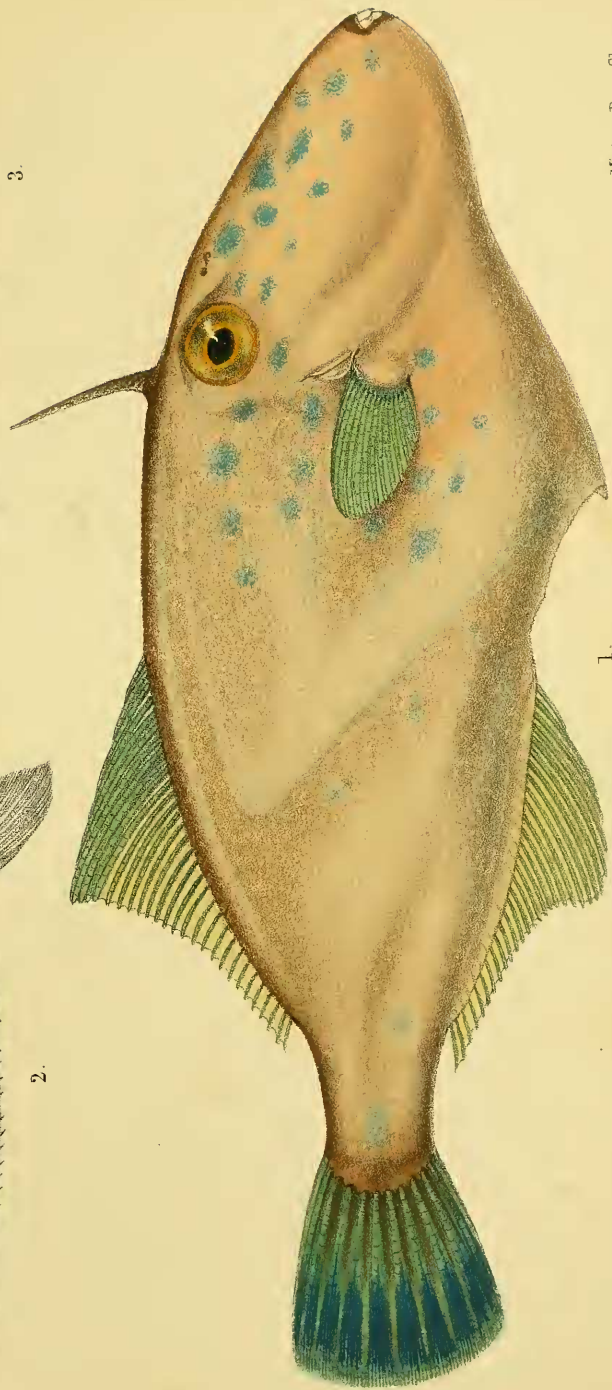
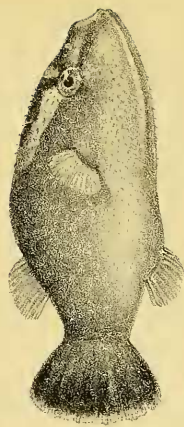
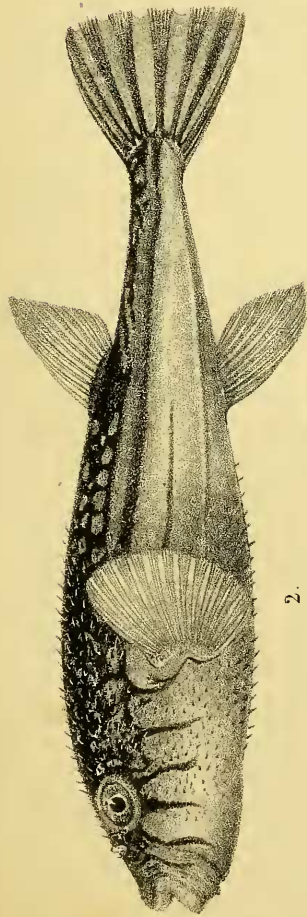
PART I.—CLASSIFICATION.

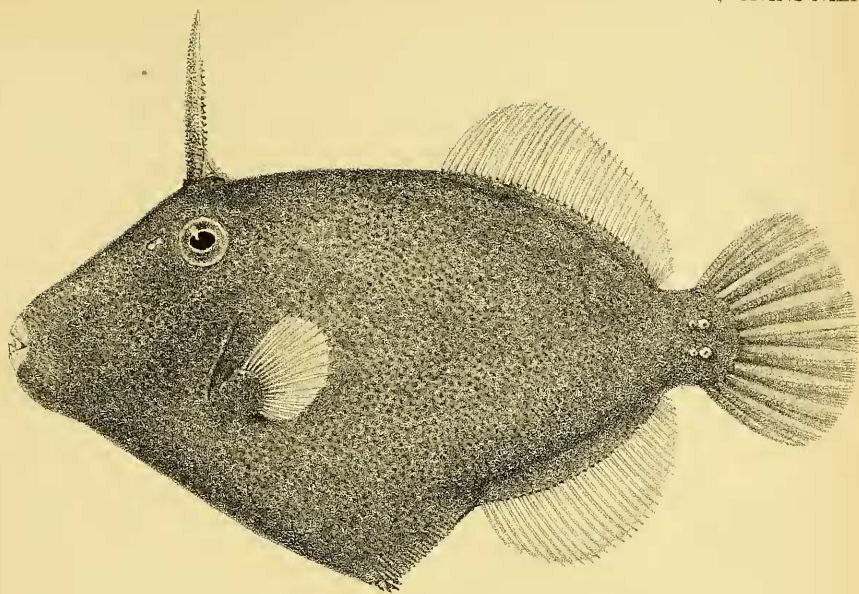
In the systematic account which follows are embodied the results of a study of the Plectognathous fishes, and especially of their osteology, which I have made. The numerous characters of importance which have hitherto been overlooked or misunderstood by ichthyologists will serve as an apology for the present paper. My sincere thanks are due to Mr. Boulenger for criticism and suggestions, which his wide experience has made invaluable.

The Plectognathi are here treated of as a distinct suborder, as

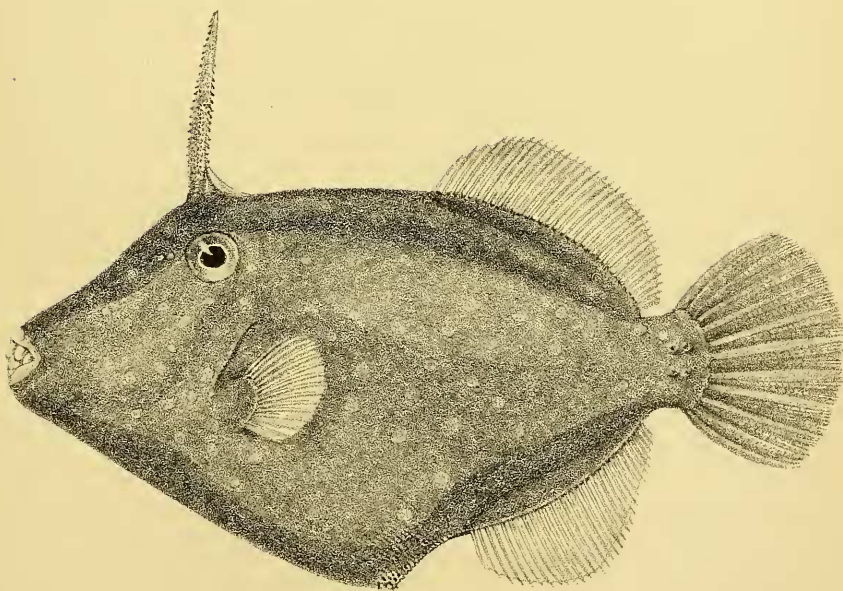
¹ Communicated by G. A. BOULENGER, V.P.Z.S.

² For explanation of the Plates, see p. 303.





2.



1.

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1. PSEUDOMONACANTHUS MULTIMACULATUS.

2. PSEUDOMONACANTHUS PUNCTULATUS.

although there can be no question as to the close relationship of the less specialized forms to the Acanthuridæ, their differences from that family are sufficiently great to admit of a definition which separates them from the Acanthopterygii, and at the same time includes the more aberrant and specialized forms.

The feature of most importance in diagnosing the suborder Plectognathi is the absence of ribs, although in some well-ossified epipleurals are present which have been mistaken for ribs. Two divisions are recognized, for which the names Sclerodermi and Gymnodontes, originally proposed by Cuvier, are retained. The Triodontidæ, however, are removed from the latter division and placed in the former; the structure of their pectoral arch and vertebral column, as well as the presence of a pelvis and of well-ossified epipleurals, indicating their close relationship to the Triacanthidæ and Balistidæ; whilst the coalescence of the teeth in the jaws is a feature of little importance, and has, as probably as not, originated independently in these fishes and in the Gymnodontes.

The Ostraciontidæ do not seem to me to differ sufficiently from the Sclerodermi to rank as another division—Ostracodermi. Their very close relationship to the Balistidæ is apparent in their physiognomy and in the structure of their skeleton; whilst the absence of epipleurals and of the pelvis is obviously due to the development of the exoskeleton, which, however, is not very different from that of *Balistes*, many species of which have exoskeletal plates distinctly hexagonal in certain areas. I have inserted notes after the diagnoses, explaining the omission of characters before used or the addition of those now used for the first time.

Suborder PLECTOGNATHI.

Similar to the Acanthopterygii, but without ribs; with the post-temporal short, simple, and completely united by suture to the squamosal, and the pelvic bones, if present, more or less completely co-ossified. Branchial apertures very restricted. Pre-maxillaries and maxillaries often firmly united, opercular bones more or less reduced, and scales usually osseous or spinate.

Cuvier characterized the Plectognathi as having no ribs, but other systematists have generally agreed that ribs are present in *Balistes*, *Triacanthus*, *Triodon*, &c. I find that the so-called ribs of the Triacanthidæ and Balistidæ are epipleurals, which are attached to the anterior caudal vertebræ as well as to the præcaudals (text-fig. 56, p. 286), and are intermuscular bones, not bordering the abdominal cavity. I have unfortunately had no opportunity of examining the skeleton of *Triodon*, but have had to rely on the memoirs of Hollard¹ and Dareste²; but I think I am justified in supposing that in *Triodon*, as in *Balistes* and *Triacanthus*,

¹ Ann. Sci. Nat. (3) xx. 1853, p. 71; (4) viii. 1857, p. 275, and (4) xiii. 1860, p. 1.

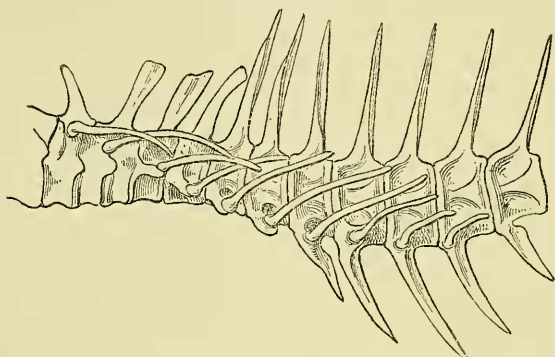
² Ann. Sci. Nat. (3) xii. 1849, p. 68, and (3) xiv. 1850, p. 105.

which it so closely resembles in other skeletal characters, the so-called ribs are epipleurals.

In the Plectognathi the post-temporal is more reduced and more intimately connected with the skull than in the Acanthuridæ, in which family it is attached by its proximal and distal ends, but separated from the skull by a foramen for most of its length.

The co-ossification of the pelvic bones is more complete in these fishes than in the Acanthuridæ.

Text-fig. 56.



Præcaudal and anterior caudal vertebræ, with epipleurals, of *Balistes aculeatus*.

In Dr. Gill's diagnosis of the Plectognathi occur the words: "The elements of the lower jaw consolidated into two pieces representing the rami;" this applies very well to the Sclerodermi, but in the Gymnodontes the suture between dentary and articulare is quite evident, and in *Mola* at any rate these bones can scarcely be described as consolidated. Another character used by Gill to define the Plectognathi is "Interoperculum detached from the other opercular bones, reduced and more or less rod-like in form." I find that in the Sclerodermi this bone is rod-like anteriorly, and posteriorly expanded and attached to the sub-operculum, this posterior portion being in some cases, e. g. *Triacanthus*, strongly ossified, in others, e. g. *Ostracion*, almost entirely membranous. In the Gymnodontes it is rod-like, but only in the Tetrodontidæ is it unconnected posteriorly with the suboperculum.

Division I. SCLERODERMI¹.

Supraclavicle vertical; pterygials (pectoral basalia) not enlarged, movably attached by ligament to the scapula and coracoid, three to the former and one to the latter. All the vertebræ with the neural arches forming a single spine. *Basis cranii* more or less distinctly double. Dentary and articulare completely co-ossified.

¹ *Trachycephalus* De Vis (*nec* Tschudi), described as a Scleroderm in Proc. Linn. Soc. N.S.W. viii. 1883, p. 455, is evidently not a Plectognath.

Spinous dorsal, if present, of few rays; no anal spines; ventrals, if present, each represented by a spine (rarely with the addition of one or two rudimentary soft rays). Caudal rays in small number, ten to eighteen.

Four families: Triacanthidæ, Triodontidæ, Balistidæ, and Ostraciontidæ.

In the fishes of this division the pectoral arch is very similar to that of the Acanthuridæ, except that the post-temporal is completely united suturally to the squamosal. The vertebral column also is like that of Perciform fishes; and although Dareste has ascribed to *Triodon* diapophyses on the posterior præcaudal and most of the caudal vertebræ, it is evident, from studying his figure and comparing with skeletons of *Triacanthus* and *Balistes*, that he is referring to the præzygapophyses, which are somewhat enlarged in this region in all these fishes.

Family 1. TRIACANTHIDÆ.

Præcaudal vertebræ with parapophyses from the third or fourth to the last; epipleurals present. Præorbital not ossified; ethmoid region high, a large nasal cavity bounded by ethmoid and præfrontal; palatine arch firmly united to the skull; premaxillaries protractile, free from the maxillaries; teeth in the jaws separate, conical or incisor-like; palate toothless; fourth upper pharyngeals toothed; lower pharyngeals separate; opercular bones reduced, but with their normal relations. Pelvis present, firmly united to the pectoral arch. Two nostrils on each side. Four gills, a slit behind the fourth; pseudobranchiæ present; six branchiostegals. Scales small, sometimes spinate or osseous. Spinous dorsal with two to six spines; soft dorsal and anal of moderate length or rather short; ventrals each represented by a strong spine, with an inner basal knob which locks it when everted, rarely with the addition of one or two rudimentary soft rays. Air-bladder present.

Genera.

1. TRIACANTHUS¹ Cuv.—Body compressed, caudal peduncle long and slender. Scales small, rough. Lateral line present. D. IV–V, 22–25; A. 16–20. Ventrals without soft rays. Caudal forked, with 12 rays. A series of incisors in each jaw, with a few inner rounded teeth. Twenty vertebræ.

2. TRIACANTHODES² Bleeker. — Body compressed, caudal peduncle short. Scales small, juxtaposed. No distinct lateral

¹ The Oligocene genus *Acanthopleurus* Agassiz has a rounded caudal, but in other respects seems scarcely different from *Triacanthus*.

² *Spinacanthus* Agassiz, from the Eocene of Monte Bolca, may belong to this family. It resembles *Triacanthodes* in its dorsal, anal, and caudal fins, except that the six dorsal spines are very long and strong. The eye is placed high, below the first dorsal spine, and the teeth are stout and conical. The pelvis and ventral fins were apparently not strongly developed, and Gill considers this fish to be the type of a separate family.

line. Dorsal with V-VI spines. Soft dorsal and anal rather shorter than in *Triacanthus*; ventrals usually with one or two rudimentary soft rays; caudal rounded. Jaws with a series of conical teeth, and usually a few inner teeth. *Hollandia* Poey seems not distinct from this genus.

3. *HALIMOCHIRURGUS* Alcock.—Body low, compressed, with short caudal peduncle. Scales small, spinate. No lateral line. Snout much produced, lower jaw projecting. D. II, 13; A. 12. Ventrals without soft rays. Caudal rounded. Teeth very small, conical, in a single series.

Family 2. TRIODONTIDÆ.

Præcaudal vertebrae without parapophyses; epipleurals well-developed. Premaxillaries not protractile, firmly united to the maxillaries; teeth in the jaws coalescent. Pelvis represented by a single long bone, movably attached to the pectoral arch. No spinous dorsal; soft dorsal and anal short; no ventrals. Abdomen with a dilatable sac, kept expanded by the movable pelvis; lower part of sac a flap of skin into which the air does not enter. In other characters like the *Triacanthidæ*.

Genus.

TRIODON.—Body compressed, caudal peduncle long and slender. Scales osseous. Caudal forked, with 18 rays. Twenty vertebrae.

Although unable to examine a skeleton of this genus, a study of the figures and descriptions published has convinced me that the skull, vertebral column, and pectoral arch are extremely like those of *Triacanthus*, whilst the scales, movable pelvis, ventral sac and flap are similar to those of the *Balistidæ*. The only features which link this family to the *Tetrodontidæ*, in the neighbourhood of which it has generally been placed, are the comparatively unimportant characters of the coalesced teeth and absent spinous dorsal. It would be interesting to know whether the fourth upper pharyngeals are well-developed and toothed, as in *Triacanthus*, or rudimentary and toothless, as in *Balistes*.

Family 3. BALISTIDÆ.

Præcaudal vertebrae with well-developed parapophyses to which epipleurals are attached. Præorbital more or less ossified. Ethmoid region long, without distinct nasal cavities. Palatine movably articulated with ectopterygoid, or else entirely free from it. Premaxillaries not protractile, firmly united to the maxillaries. Fourth upper pharyngeals rudimentary, not toothed. Incisor-like teeth in the jaws. Pelvis long, movable. Spinous dorsal with one to three spines, the first, if strong, followed by a second which locks it when erected. Soft dorsal and anal long or of moderate length. Ventrals, if present, represented by a single

short rough spine at the end of the pelvis. Most of the præ-caudal interneurals co-ossified to form a bony trough, attached to the skull, and receiving the retracted dorsal spines. In other characters similar to the two preceding families.

Genera.

1. *BALISTES* Linn.¹—Body compressed, caudal peduncle short. Scales moderate or large, juxtaposed, osseous. Jaws usually even in front. Gill-openings behind the eyes. Dorsal usually with 3 spines—the first strong and just behind the eye, the second locking it when erected, the third, if present, remote from them. Soft dorsal with 23–35 rays. Anal with 20–30. Caudal rounded or truncate, the outer rays often more or less produced. Pelvis projecting. Ventrals represented by a short, rough, movable spine. The movable pelvis, abdominal sac, and ventral flap are very similar to those of *Triodon*, but much less developed. Palatine T-shaped, the cross-piece articulating with ethmoid and maxillary, the vertical limb with the ectopterygoid. Vertebrae 18.

2. *MONACANTHUS* Cuv.—Differs from *Balistes* in that the scales are smaller; the palatine is a straight rod attached to maxillary and ethmoid, having lost the lower vertical limb which in *Balistes* articulates with the ectopterygoid; the third dorsal spine is always absent and the caudal always rounded. The first dorsal spine is above the eye, and if it has distinct barbs these are usually arranged in two series. The gill-openings are often below the posterior part of the eye. There are 18 vertebrae.

In this genus are included all those species of *Monacanthus*, as understood by Günther, with a movable ventral spine.

The transition is perfect from those with a rough dorsal spine without distinct barbs, to those with a series of minute barbs on each side, and so to those with barbs strongly developed.

M. penicilligerus Cuv. belongs to this genus, the ventral spine being movable, and the barbs on the dorsal spine exactly similar to those of the closely-allied *M. tomentosus*, although their regular arrangement is obscured by the well-developed fleshy filaments. In the development of the ventral sac and flap, some species of this genus almost rival *Triodon*.

3. *PARALUTERES* Bleeker.—Differs from *Monacanthus* in that the single dorsal spine is weak, not fully erectile, and the ventral spine is absent, or small and fixed.

4. *PSEUDALUTERES* Bleeker.—Differs from *Monacanthus* in that the dorsal spine is in advance of the orbit, the ventral spine is absent, and the pelvis is entirely concealed.

5. *PSEUDOMONACANTHUS* Bleeker.—Differs from *Monacanthus* in that the ventral spine is immovable, ankylosed to the pelvis, and

¹ The Oligocene genus *Acanthoderma* Agassiz is scarcely distinguishable from *Balistes*.

the barbs of the dorsal spine, if distinct, are usually in four series. There are 19 or 20 vertebræ. In this genus the gradation is perfect from those species without barbs to those with four equidistant series of strong barbs.

6. *ALUTERA* Cuv.—Differs from *Pseudomonacanthus* in that the dorsal spine is feeble, the ventral spine is absent, the pelvis is entirely concealed, and the dorsal and anal rays usually in greater number. The lower jaw is projecting, the gill-openings oblique and below the eye, and the vertebræ number 21.

7. *PSILOCEPHALUS* Swainson.—Differs from *Alutera* in its more elongate body, very feeble dorsal spine, lower jaw with a barbel, gill-openings in advance of the eye, and vertebræ numbering 29–30.

This family has well-defined characters, and the relations of the various genera are very clear; its division into subfamilies is without value, and if *Balistes* and *Psilocephalus* are to rank as distinct families, *Monacanthus*, *Alutera*, *Paraluteres*, and *Pseudaluteres* should receive the same treatment, and the Balistidæ (as here understood) be raised to the rank of a division.

Some authors have stated that the symplectic is not ossified in the fishes of this and the next family. I find that in all cases it is present as a small but distinct ossification attached to the lower margin of the metapterygoid between stylo-hyal and quadrate; the stylo-hyal has shifted its attachment forwards from the hyomandibular to the anterior part of the lower margin of the metapterygoid, and has, as it were, pushed the symplectic in front of it.

Family 4. OSTRACIONTIDÆ.

Closely allied to the Balistidæ, but with feeble parapophyses, no epipleurals, præorbital not ossified, palatine immovable, pelvis absent, no spinous dorsal, no ventrals, soft dorsal and anal short. Clavicles, coracoids, and post-clavicles much expanded. Scales represented by large, juxtaposed, bony plates, mostly hexagonal and immovably united.

Genera.

1. *ARACANA* Gray.—Body ovate or orbicular. Carapace ceasing before the dorsal and anal fins, with more or less distinct longitudinal ridges, 3 on each side, and often a dorsal and ventral ridge; some isolated plates on the caudal peduncle. D. 10–12. A. 10–12. Caudal truncate or rounded. Sixteen vertebræ, not elongate, subequal in length except the two preceding the square hypural, which are shortened.

2. *OSTRACION* Linn.—Body 4- or 5-sided; carapace extending beyond and closed behind the anal fin, with two prominent ridges on each side and often a dorsal ridge. Caudal peduncle naked. D. 9–10. A. 9–10. Caudal truncate or rounded. Sixteen

vertebræ, not elongate, subequal in length except the three preceding the square hypural, which are extremely shortened.

3. *LACTOPHRYS* Swainson.—Body 3-sided ; carapace with three prominent ridges, a dorsal and two ventro-lateral. Vertebrae fourteen, the first eight elongate, the four preceding the oblong hypural shortened. In other characters like *Ostracion*.

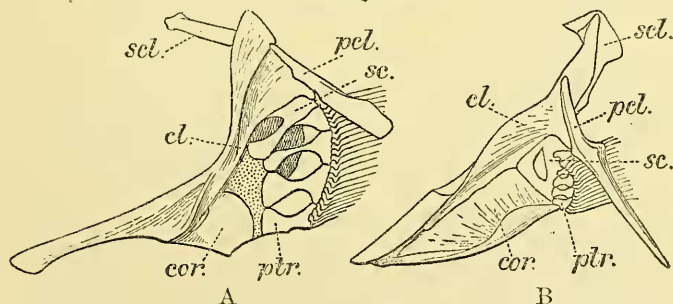
Division 2. GYMNOdontES.

Supraclavicle oblique, sometimes nearly horizontal ; lower three pterygials enlarged and immovably united to the coraco-scapular cartilage ; upper pterygial small, suturally united to the scapula (see text-fig. 57). Anterior vertebrae with bifid divergent neural spines. *Basis cranii* simple. Suture between dentary and articulare evident. Pelvis absent. No spinous dorsal ; no anal spines ; no ventrals ; caudal rays, if present, ten to twelve in number.

Three families : Tetrodontidæ, Diodontidæ, Molidæ.

I cannot find that the true interpretation of the bones of the pectoral arch in these fishes has been previously published. On a superficial examination there appears to be no scapula, and the pectoral fin to be supported by a series of four enlarged pterygials. In fact, the united upper pterygial and scapula together resemble one of the enlarged pterygials, both in size and shape, whilst the

Text-fig. 57.



Right half (inner side) of pectoral arches of (A) *Diodon punctulatus* and (B) *Balistes verrucosus*.

scl., supraclavicle ; cl., clavicle ; pcl., postclavicle ; sc., scapula ; cor., coracoid ; ptr., pterygials.

scapular foramen corresponds to one of the series of interspaces between them. The feature of the pterygials being immovably attached to the scapula and coracoid, either directly or synchronously, is worth notice. The pectoral arch is so strikingly similar in all three families, that Siebenrock's suggestion that in *Mola* the bone which attaches the clavicle to the skull is the post-temporal, and not the supraclavicle as in Tetrodontidæ, cannot be accepted.

It has been asserted that the term *spina bifida* is not correctly applied to the neural spine of the anterior vertebræ in these fishes, because the neural canal is closed; but in the Molidæ this is not the case, and in the Diodontidæ the neural canal is open above in the posterior præcaudal region; the anterior bifid spines are in all cases obviously homologous and forming one series with the single neural spines which succeed them, and when the neural canal is closed by a bony roof this must be regarded as a secondary feature, due to the meeting of outgrowths from the base of the neural spine of each side after they have separated.

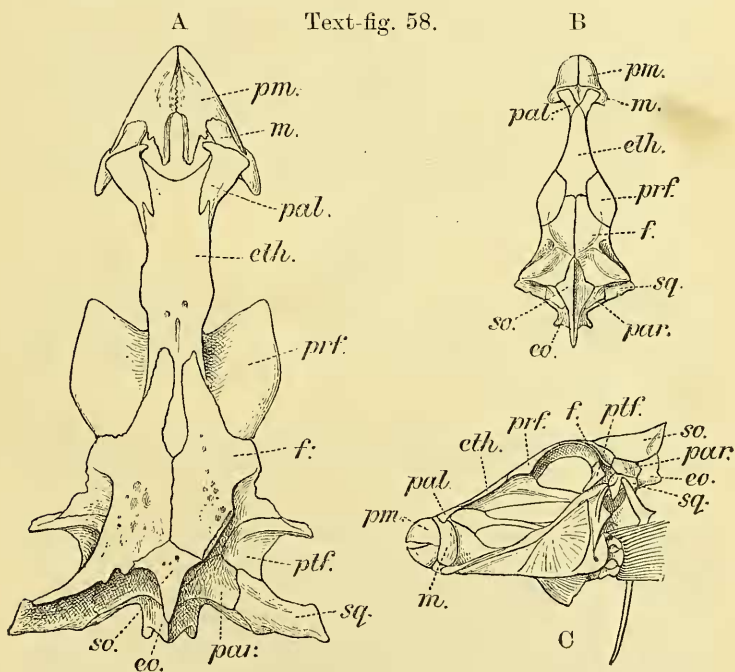
Family 1. TETRODONTIDÆ.

Præcaudal vertebræ without parapophyses, the first four or five with bifid neural spine and closed neural arch; no epipleurals. Præorbital not ossified; palatine firmly united to the skull; no distinct bony nasal cavity; premaxillaries not protractile, united to maxillaries; teeth in the jaws coalescent, in each forming a beak with median suture; palate toothless; fourth upper pharyngeals present, toothed; lower pharyngeals separate; interoperculum a long rod, attached to inner face of præoperculum, sometimes connected with operculum, never with suboperculum. Nostrils various. Four branchial arches, the fourth not bearing a gill, not followed by a slit; pseudobranchiæ present; six branchiostegals, the first a broad plate. Skin naked, usually with movable spines, rarely with bony plates. Caudal peduncle normal. Skeleton well-ossified. Belly very inflatable. Air-bladder present.

Many authors have failed to understand the evolution of the nasal organs in this family, as is shown by the wording of their diagnoses, such phrases as "nostrils represented by two solid tentacles on each side," "nostril with a tube," &c. being quite misleading. In the more primitive forms (*Lagocephalus*) there are two nostrils on each side, situated in an oval nasal area, which overlies an internal nasal sac, exactly as in *Balistes*, *Triacanthus*, &c. From these we pass to fishes (*Spheroides*) in which the nasal area is raised up into a more or less prominent tubular papilla bearing the two nostrils, whilst the nasal sac is scarcely sunk below the level of the skin, and is in great part represented by the interior of the papilla, on the walls of which are the terminations of the olfactory nerve. By the absorption of the septum between the nostrils at the end of the papilla they become confluent, and we get a circular tube produced terminally into two more or less distinct lips or tentacles, in the more specialized of which the circular tube is short and constricted, so that we have two tentacles, on the inner surface of which are the terminations of the olfactory nerve, united basally. Thus when the nostrils become confluent the interior of the nasal sac is exposed, and in some species of *Tetrodon* it may be said to be raised above the level of the skin. In *Tropidichthys* the circular tube has degenerated to an inconspicuous rim with a minute aperture. In

Xenopterus and *Chonerhinus*, on the contrary, it has become excessively developed.

Dr. Gill (Proc. U.S. N. M. xiv. pp. 705-720, pl. xxxiv. (1890)) has arranged the fishes which I here include in the family Tetrodontidæ in three families: Tetrodontidæ, Chonerhinidæ, and Canthigasteridæ, which are chiefly distinguished by supposed cranial differences. In the Canthigasteridæ and Chonerhinidæ the post-frontals are said to meet in the middle line, thus separating the frontals from the supraoccipital. An examination of the skeletons has convinced me that in these fishes the post-frontals are confined to the sides, and that the frontals are in contact with the supraoccipital. The erroneous statements and figures of Hollard have met with too ready an acceptance, that author having mistaken ridges on and fissures in the frontal bones for sutures between them and the post-frontals. The Canthigasteridæ are also defined as having a long prominent



A. Skull of *Tetrodon scleratus*, seen from above (on the right the postero-lateral process of the frontal has been removed).

B. Skull of *Tropidichthys papua*, seen from above.

C. " " " side view.

pm., premaxillary; m., maxillary; pal., palatine; eth., ethmoid; prf., præfrontal; f., frontal; ptf., postfrontal; sq., squamosal; par., parietal; eo., exoccipital; so., supraoccipital.

ethmoid, in opposition to the Tetrodontidæ, with short or narrow ethmoid, not prominent. I find that in *Tetrodon lagocephalus*, *scleratus*, *levigatus*, &c. the ethmoid is long, by no means narrow, and at least as prominent as in any species of the so-called Canthigasteridæ. The Chonerhinidæ are also separated on account of the increased number of vertebræ and dorsal and anal rays, but as in the Tetrodontidæ the vertebræ vary from 17 to 22 in number, and the dorsal rays from 6 to 19, it is scarcely logical to separate from them *Chonerhinus*, with 24 vertebræ and 25-26 dorsal rays, nor *Xenopterus* with 29 vertebræ and 32-38 dorsal rays, on that account alone.

The question as to how many genera it is convenient or useful to recognize in this family is a very vexed one. Perhaps, on account of the many strange and abnormal features which unite the Tetrodontidæ and distinguish them from more typical fishes, one is rather apt to overlook the differences which exist among them; nevertheless, it is very evident that many of the so-called genera are incapable of definition and cannot be maintained.

The genera *Ephippion*, *Tropidichthys*, *Chonerhinus*, and *Xenopterus* can be easily defined; but I am inclined to unite the remaining species in a single genus *Tetrodon*, as the differences in the structure of the skull and of the nasal organ show so many gradations that they can hardly be used for generic diagnoses.

In *Tetrodon psittacus* Bl. Schn. I find that the frontals extend to the orbital margins, therefore *Colomesus* Gill, if a valid genus, has not been correctly diagnosed.

Genera.

1. *TETRODON* Linn.—Body oblong or elongate, broad or somewhat compressed, prickly or smooth. D. 6-19. A. 6-17. Vertebræ 17-22. Präfrontals, frontals, and post-frontals with lateral expansions which form the orbital roof. Nostrils either separate or confluent.

2. *EPHIPPION* Bibr.—Differs in having the body armed with bony plates. Nostrils confluent. Skeleton unknown.

3. *TROPIDICHTHYS* Bleeker.—Body compressed. D. 8-10. A. 8-10. Vertebræ 18. Nostrils confluent, a single small aperture on each side. Ethmoid long, narrowed forwards. Posterior part of frontals with paired lateral crests.

4. *CHONERHINUS* Bleeker.—Differs from *Tetrodon* in that the dorsal and anal fin-rays are in increased number, as are the vertebræ (D. 25-26. A. 23-25. Vertebræ 24). The præfrontals small, without lateral expansions. The nasal organs are very similar to those of *T. patoca*, but developed into a large funnel-shaped rim.

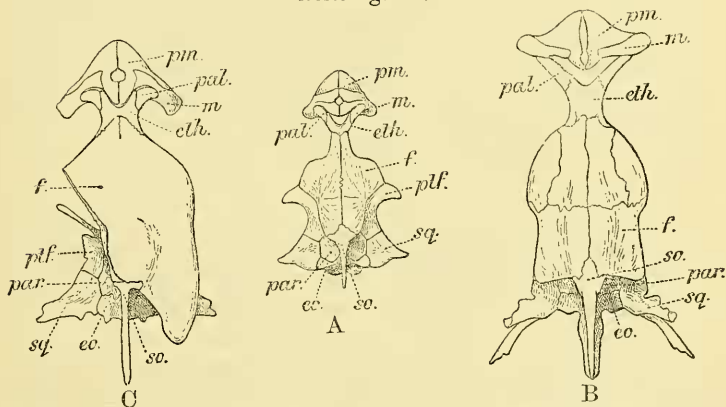
5. *XENOPTERUS* Hollard.—Differs from *Chonerhinus* in having more vertebræ and dorsal and anal rays (Vertebræ 29. D. 32-38.

A. 28-32), whilst the frontals have large postero-lateral expansions, completely roofing-in the post-frontals, which are invisible from above.

[Since the reading of this paper I have been in communication with Dr. Pellegrin of the Paris Museum, who has examined the skeleton of *Xenopterus bellangeri* described by Hollard, and also the spirit-specimens referred to that species. These latter he is unable to distinguish from *X. naritus* Richardson; but the skull figured by Hollard differs considerably from that of *X. naritus*, and, unless these differences should prove to be sexual, must be regarded as belonging to a distinct species, although the number of vertebræ (29) and of fin-rays (D. 34, A. 29) are the same in each case.

In *X. bellangeri* the frontals are scarcely thickened, they show lines resembling sutures, corresponding to similar lines in *Chonerhinus modestus* Bleeker, and due to the texture of the bone, and

Text-fig. 59.



Skulls of (A) *Chonerhinus modestus*, (B) *Xenopterus bellangeri*, and (C) *Xenopterus naritus*, seen from above; in the latter the left postero-lateral extension of the frontal has been cut away. Lettering as in text-fig. 58.

their postero-lateral expansions do not extend over the parietals and squamosals. *X. naritus* differs in having very thick frontals, without any trace of lines of ossification and even the median suture obscure, and with strong postero-lateral expansions roofing-in parietals and squamosals.

Through the kindness of Dr. Pellegrin, to whom I take this opportunity of expressing my gratitude for the trouble he has taken, I am enabled to reproduce a drawing of the skull of *X. bellangeri* already figured by Hollard, for comparison with those of *X. naritus* and *Chonerhinus modestus*. Hollard's skeleton must be regarded as the type of *X. bellangeri*; it is 280 mm. in total length.—Dec. 20, 1902.]

Family 2. DIODONTIDÆ.

All the præcaudal vertebræ with bifid neural spine; anterior caudals with bifid divergent hæmal spines instead of closed hæmal arch. Behind the dorsal and anal fins the neural and hæmal spines are single, but bifurcate distally. Teeth in the jaws coalescent, forming a beak without median suture; internal dentigerous plates well-developed. Interoperculum rod-like, attached posteriorly to the rod-like anterior limb of the suboperculum. In other characters essentially similar to the Tetrodontidæ, but with a less strongly ossified skeleton and larger dermal spines.

I am inclined to think that only two genera are capable of clear definition: DIODON, corresponding to *Diodon*, *Chilomycterus*, *Dicotylichthys*, and *Atopomycterus* of Günther's Catalogue, of which *Trichodiodon* and *Trichocyclus* are probably young forms; and LYOSPHERA.

The skeleton is in all exactly similar, and the differences in the nasal organs are not well marked, as although some species have a tubular papilla with two nostrils, others a two-lipped tube, in many of the former the septum between the nostrils is so easily and so often torn that the condition in the latter results. Also those species with two-rooted movable spines are connected with those with three-rooted fixed spines by a series of species with both sorts of spines in varying proportions.

Genera.

1. DIODON Linn.—Body stout, with strong spines. Nostrils in a tubular papilla, sometimes confluent. D. 10–15. A. 10–15. Vertebræ 21 or 22. Frontals much expanded. Post-frontals in contact with supraoccipital, separating parietals and frontals.

2. LYOSPHERA Evermann & Kendall.—Body oblong ovoid, covered with feeble spines attached to papery plates. Caudal peduncle very short. Two nostrils in a tubular papilla. D. 11. A. 4.

Family 3. MOLIDÆ.

Præcaudal vertebræ without parapophyses; anterior præcaudals with divergent bifid neural spines and neural canal not roofed in; no epipleurals. Præorbital not ossified; no distinct bony nasal cavity; palatine firmly united to the skull; præmaxillaries not protractile, firmly united to the maxillaries; teeth in the jaws coalescent, forming a beak without median suture; palate toothless; fourth upper pharyngeals present, toothed; lower pharyngeals separate; interoperculum rod-like, attached posteriorly to the rod-like anterior limb of the suboperculum. Two nostrils on each side. Gills four, a slit behind the fourth; pseudobranchiæ present¹; six branchiostegals, the first not enlarged. Skin

¹ The "accessory opercular gill" of so many authors is only a well-developed pseudobranch.

rough or tessellated. Body truncate posteriorly, without caudal peduncle. Caudal fin absent, the dorsal and anal fins confluent posteriorly. Skeleton moderately ossified. Air-bladder absent.

Genera.

1. *MOLA* Cuv.—Body ovate, compressed; skin thick, rough. Vertebrae 17.

2. *RANZANIA* Nardo.—Seems chiefly different from *Mola* in having the body covered with small hexagonal juxtaposed plates.

PART II.

Notes on some Plectognathous Fishes, and Descriptions of some new species in the British Museum Collection.

In these descriptions the length of head is measured from the tip of the snout to the upper end of the gill-opening, the depth of body at the level of the vent, the movable pelvis or inflatable belly making the measurement of the greatest depth uncertain.

BALISTES NAUFRAGIUM Jordan & Starks.

In descriptions of this species a feature of some importance has been overlooked, *i. e.* that the scales on the cheeks are arranged in parallel horizontal series, with naked lines intervening between those in front of the pectoral, and although closely allied to *Balistes capriscus* Linn. it is still closer to *B. flavimarginatus* Rüpp., and should have been placed in the genus *Xanthichthys* recognized by the authors who named it.

Incidentally this species demonstrates of what little value are genera based on features so trivial as those supposed to separate *Balistes* from *Xanthichthys*.

BALISTES CASTANEUS Richardson.

This species, described by Richardson in the 'Voyage of the Sulphur, Fishes' (p. 126, pl. 59), has been included by Günther in the synonymy of *Balistes capriscus* Linn., from which it differs in many ways, and I therefore take the opportunity of redescribing Richardson's type specimen.

Depth of body twice in total length, length of head 3 times. Snout 3 times as long as the eye-diameter, which is $\frac{3}{4}$ of the interorbital width, which is less than $\frac{1}{3}$ the length of head and equal to the length of the gill-opening. A groove below the nostrils; 2 or 3 enlarged plates behind the gill-opening. D. III, 28. A. 26. The first dorsal spine above the gill-opening, with about 8 vertical rows of minute tubercles anteriorly, somewhat curved, its length $1\frac{3}{4}$ times in the length of head; second and third spines prominent; soft dorsal somewhat elevated anteriorly, the fifth ray the longest, longer than the first dorsal spine. Anal similar, but not so deep. Caudal truncate, with the outer rays slightly produced. Scales on the cheeks in oblique series without naked lines intervening, on the caudal peduncle not bearing

spines or tubercles. About 70 in a longitudinal series from the gill-opening to the caudal, about 20 in an oblique series from the base of the pectoral to the vent, and about 50 in an oblique series from the origin of the dorsal to the ventral spine.

Yellowish-brown, with darker dots and points on the body and fins. Lips white, with a semicircular white fold behind them on each side.

Pacific. Total length 135 mm.

Balistes capriscus has rather larger scales, and in a specimen of the same size the eye-diameter is about $3\frac{2}{3}$ times in the length of snout, $1\frac{3}{4}$ times in the interorbital width, and there are also other differences.

PSEUDOMONACANTHUS PUNCTULATUS, n. sp. (Plate XXV. fig. 2.)

Depth of body $2\frac{1}{4}$ times in the total length, length of head 3 times. Snout nearly straight, but very slightly concave, about 4 times as long as the eye-diameter, which is $\frac{2}{3}$ of the interorbital width. Gill-opening $1\frac{3}{4}$ times as long as the eye-diameter, its upper and lower ends below the posterior and anterior margin of the eye respectively. D. II, 36. A. 32. Dorsal spine slightly in advance of the middle of the eye, with vertical rows of moderate-sized granules or tubercles anteriorly, the two rows on each side of the median row enlarged, but not forming distinct barbs; each lateral posterior edge with a row of conical tubercles (barbs) in its lower half; the length of the spine $1\frac{2}{5}$ times in the length of head. Second ray of spinous dorsal not prominent. Soft dorsal and anal similar, rounded, the longest ray $\frac{2}{5}$ the length of head. Pectoral as long as the gill-opening. Caudal rounded, half the length of head. Caudal peduncle deeper than long, with two pairs of small curved spines with points directed forward on each side. Ventral spine moderate, barbed. Scales represented by minute osseous granules.

Brown, with traces of numerous small darker spots on the sides. Caudal brownish, other fins immaculate.

Closely allied to *Pseudomonacanthus pardalis* Rüpp., which has a somewhat more declivous concave snout, tubercles on dorsal spine minute, slightly shorter head, narrower gill-opening, narrower interorbital space, &c.

A single specimen, 190 mm. in length, from Tahiti.

PSEUDOMONACANTHUS MULTIMACULATUS, n. sp. (Plate XXV. fig. 1.)

Depth of body $2\frac{1}{6}$ times in the total length, length of head 3 times. Snout slightly concave, about $3\frac{3}{4}$ times as long as the eye-diameter, which is $\frac{2}{3}$ of the interorbital width. Gill-opening $1\frac{1}{2}$ times as long as the eye-diameter, its upper and lower ends below the posterior and anterior margins of the eye respectively. D. II, 36. A. 32. Dorsal spine in advance of the middle of the eye, $1\frac{1}{4}$ times in the length of head, armed almost exactly as in the preceding species, but with the anterior double row of

enlarged tubercles more prominent. Soft dorsal and anal similar, rounded, their longest ray half as long as the dorsal spine. Pectoral scarcely longer than the gill-opening. Caudal rounded. Caudal peduncle deeper than long, with two pairs of barbs on each side as in the preceding species. Ventral spine moderate, barbed. Scales as minute granules.

Greyish, with rounded lighter (? light blue) spots on the sides of head and body. Upper part of head and body, above a line from the tip of snout to the eye and thence to the last dorsal ray, brown. Lower part of the body with a similar brown area. Fins immaculate.

A single specimen from Tahiti, 175 mm. in total length.

Very closely allied to the preceding species, differing chiefly in the more concave snout, more strongly armed dorsal spine, and colour.

PSEUDOMONACANTHUS DEGENI, n. sp. (Plate XXIV. fig. 1.)

Depth of body equal to length of head, 3 times in the total length. Snout slightly convex, about $3\frac{2}{3}$ times as long as the eye-diameter, which is equal to the interorbital width. Gill-opening about equal in length to $\frac{2}{3}$ the eye-diameter, its upper end below the hind margin of the eye. D. II, 34. A. 33. Dorsal spine above the hind margin of the eye, without barbs, its length $2\frac{2}{3}$ in that of the head; second spine scarcely visible. Soft dorsal and anal similar, rather elevated anteriorly, the rays increasing in length to the eighth or ninth, which is the longest and equal to half the length of the head, thence decreasing to about the twentieth, the rest subequal. Pectoral almost as long as the dorsal spine. Caudal rounded, more than half the length of head. Caudal peduncle longer than deep. Scales minute, shagreen-like. Ventral spine small.

Greyish, with blue spots on the sides of the head and anterior part of the body, and on the caudal peduncle. Some faint oblique blue lines on the sides between dorsal and anal fins. Fins green.

A single specimen, 190 mm. in total length, from Melbourne Market, Australia. Mr. Degen sent with the fish a drawing showing the colours when fresh.

This species is closely allied to *Pseudomonacanthus modestus*, Gthr., *ayraudi* Gthr., and *septentrionalis* Gthr., which it resembles in physiognomy and in the shape of the fins, but all these have distinct barbs on the dorsal spine.

TETRODON INERMIS Schlegel.

This species was considered by Günther to be a variety of the Atlantic *T. levigatus*, and the descriptions of Schlegel and Day (Fishes of India, p. 701, pl. clxxx.) have not sufficiently pointed out the features which distinguish it from that species, the most noticeable of which are as follows:—In *T. inermis* the body is much broader and deeper in proportion to its length, there is no distinct lateral fold in the abdominal region, and the spines on